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ABSTRACT

The paper considers the management process within central research offices of universities, or the research divisions of universities, to determine how funded research is encouraged at research institutions. It also looks at the characteristics of those research institutions which had strong growth in the last 10 years. A telephone survey of 37 leading research universities concerning aspects of managing research activity within a changing environment. Usable responses numbered 33; an 89% response rate. Results were analzyed in terms of faculty participation (e.g., an average of 46% of faculty participate in research activities as either principle or co-investigator); research visibility (e.g., the typical institution had $97 million in research expenditures); influential environmental factors (e.g., 63% saw an increased administrative emphasis on research); and key success factors (e.g., 39% used total number of proposals or awards as a measure of success). Institutions are encouraged to increase research productivity through such means as setting specific research activity goals; recruiting and retaining outstanding research faculty; and providing assistance in writing proposals. Contains 9 references. (DB)

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This paper was presented at the Thirtieth Annual Forum of the Association for Institutional Research held at The Galt House, Louisville, Kentucky, May 13-16, 1990. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum Papers.

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Factors Contributing to Research Excellence

Abstract

What factors contribute to high quality funded research activity in research universities? What do these institutions have in common? What management strategies do they employ to encourage funded research excellence and activity? In this period of decreased or level government spending, competition for grants among research universities becomes fierce. In order to stay competitive, it is important to know what works in research management. Preliminary research has allowed us to provide some answers and to clarify some key questions on what makes a successful research program.

Introduction

University administrators who want to increase research funding share an interest in what makes a successful program. Dill (1986), noting the limited number of studies on the culture and management of academic research settings, calls for a systematic study of the processes supporting a culture of research. The need for this study is emphasized by the fact that "Up to 90% of all discoveries originate in institutions of higher education" (Kolstoe, 1975). When the economic impact of these discoveries is considered, it is easy to see that the research performed at academic institutions plays an important role in the local, state, national and even international economic environment. Many states and private corporations have realized this and have increased funding in order to reap the benefits of these discoveries (Dill, 1986). However, as is the case in all government agencies, funding levels are bounded. Thus, it is important to manage the research operation in order to effectively use these funds. How is the research operation managed? This question will be addressed at two levels. The first will be to identify management practices currently being used at outstanding research universities. A more detailed look will then be taken to determine whether certain management practices appear more successful than others.

Literature Review

While the existing literature on strategic management and its application to institutions of higher education is limited, the little that exists provides the theoretical boundaries for this study. Ellen Chaffee (1985) discussed the three levels of strategic process that have emerged from business literature. These include (1) Linear Strategy, where planning involves methodical, direct, and sequential activities; (2) Adaptive Strategy, where there is enough flexibility in the system to allow for taking advantage of environmental opportunities while reacting to potential threats; and (3) Interpretive Strategy, where the individuals that make up the organization deal with the environment independently as changes occur, but do so with a similar cultural conscience so that they tend to work for the good of the university.

The way managers make decisions in an organization is addressed by Gorry and Scott Morton (1986) who present an information system model wherein "the purpose of management activity" is associated with "the way in which the manager deals with the problems that confront him." In essence this model determines the necessary information requirements by associating management activities with the different levels of structure inherent in the decision making process.

The three types of management activity are outlined as strategic planning, management control, and operational control. Strategic planning is the process of defining and altering objectives, allocating resources, and setting policies related to the acquisition and distribution of resources. Management control is the process that ensures that the necessary resources are obtained and used to accomplish organizational objectives in an effective and efficient manner. Finally, operation control is the process that assures that specific tasks are completed in an effective and efficient manner.

Management control decisions fall on a continuum ranging from structured to unstructured. Structured decisions are those decisions that are repetitive and routine (how many of Part A are required to make 1,000 widgits) and involve little human interaction. Data is plugged into a formula or program and the result determines the decision. Unstructured decisions are unique and non-reoccurring (How should a 10% budget cut be distributed among departments?). There is no standard method for dealing with these decisions. Unstructured decisions tend to rely on human thought. While they may be supported by data (what were departmental budgets last year), data alone cannot provide the answer. Semistructured decisions lie somewhere between unstructured and structured decisions. These decisions occur when parts of the decision process are structured or formula driven and other parts require human interaction.

Gorry and Scott Morton (1986) suggest that all management decisions lie somewhere in the matrix that is formed by crossing management levels with decision structure levels. While Chaffee (1985) provides models that are appropriate for decisions related to higher education that fall in the strategic planning column, it is apparent that little has been done to address other types of information models appropriate to higher education, especially for unstructured decisions within the

management and operational control levels. This paper takes a closer look at these yet to be explored areas, in particular, decision making within the management control process. Figure 1 summarizes Gorry and Scott Morton's (1986) model and includes the strategies that Chaffee (1985) outlines. In addition, those areas that will be explored in this paper are highlighted.

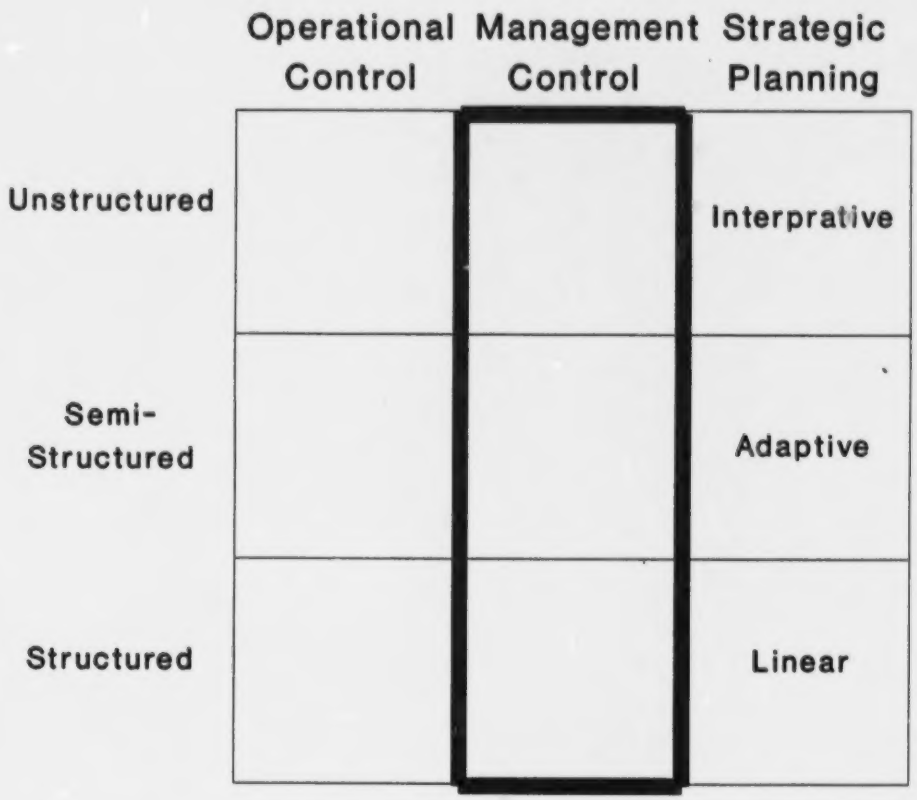
While many associate goal setting and monitoring with strategic planning, it is also important at other levels of management such as operational and management control levels. Contrary to common belief, decisions at these levels, especially in higher education, are not all formula driven. In many cases, these decisions are unstructured. As such, managers at these levels must take care to carefully monitor and control these processes.

It is suggested that those universities where research divisions have developed a management control system (MCS) that incorporates specific goals and monitors success towards meeting these goals will be the most successful research universities. While goals are commonly accepted as fundamental to effective planning and management, there may still be some who question the need for goals. These individuals should look to Fenske (1980) for a pervasive look at the need for goals. In addition, Latham & Locke (1980) provide compelling evidence that links increased performance to the setting of specific goals.

It is further suggested that goal setting alone is not enough. First, objectives must be set that provide the short term directions that will enable the university to reach its longer term goals. Second, those factors that are key to the attainment of these objectives must be defined and measured in order to monitor success toward the objectives and thus the goals.

Maciariello (1984) defines the work of the MCS as "that part of the management process that is concerned with the planning and control functions of the organization as they relate to the *non-programmed or discretionary aspects* of administration." In other words the MCS is concerned with those *unstructured* areas within the management process that involve coordinating subunits, processing information, and allocating resources. Aspects of this definition, specifically resource allocation, suggest that a MCS should be used in strategic planning; however, other aspects

Figure 1
Information Systems Framework



Adapted from: Gorry, G. A. and M. S. Scott Morton (1986). Chapter One A Framework for Management Information Systems. The Rise of Managerial Computing. Homewood, Illinois: Dow Jones-Irwin.

(coordinating subunits and processing information) suggest that it is appropriate for the management control process. Thus, it is apparent that a MCS has applications in areas other than strategic planning. In fact, multiple *coordinated* MCSs at various levels within the organization help to ensure that consistent goals and objectives are used throughout the organization.

A MCS involves setting goals and objectives; defining those variables that will be critical in reaching these goals and objectives, commonly referred to as key success factors (Maciariello, 1984) or critical success factors (Bullen and Rockart, 1981); and monitoring these variables to determine the level to which these critical or key success factors have been achieved. This process is continuous in that success is always being monitored and goals, objectives, and key success factors are necessarily altered as progress is made.

Both Maciariello (1984) and Bullen and Rockart (1981) provide excellent advice in selecting appropriate key success factors. They caution that these factors should be selected based on their importance in obtaining the prestated goals and objectives, *not* their ease of measure. They also indicate that qualitative key success factors should not be avoided. This caveat is especially important in the research arena where many of the measures of successful research are qualitative.

Purpose

This paper will focus on the management process within central research offices, or the research divisions of universities, to determine how funded research is encouraged at research institutions. A secondary purpose will be to look for the characteristics of those institutions which had strong growth in the last ten years.

Data Source

During March 1989, a telephone survey was performed of thirty-seven outstanding research universities. Information requested included both quantitative and qualitative aspects of managing and operating the research activity within a changing environment.

The survey sample population included institutions ranked in the top 100 universities by the 1987 National Science Foundation ranking of "Total and Federally Financed R&D Expenditures." The sample was selected based on change in rank from 1977 to 1987 and included 15 institutions which had an increase in rank of 10 or more positions, 12 institutions which sustained their rank within 3 positions -- 2 of these institutions maintained a position in the top 10 institutions, and 10 institutions which declined in rank by 10 or more positions.

A telephone survey was developed to investigate support for research activity. Questions included on the survey instrument fell into four main categories: faculty participation, research visibility, influential environmental factors, and key success strategies and measures. In this context faculty participation and research visibility are considered to be the generic areas from which goals would be formulated, influential environmental factors are considered to be the constraints that the universities have to work with, and key success factors are those measures that research divisions use to monitor progress toward their objectives. Figure 2 provides an overview of these constructs and their relationship to each other.

The telephone survey was administered to the 37 institutions selected. The survey resulted in 33 usable responses for an 89% response rate. Initial contact was made at the Vice President for Research level. In a number of cases, referral was made to the equivalent of the director of research activities. As would be expected, responses varied substantially among institutions; thus, quartile measurements have been provided to give the reader a better idea of response distribution.[1]

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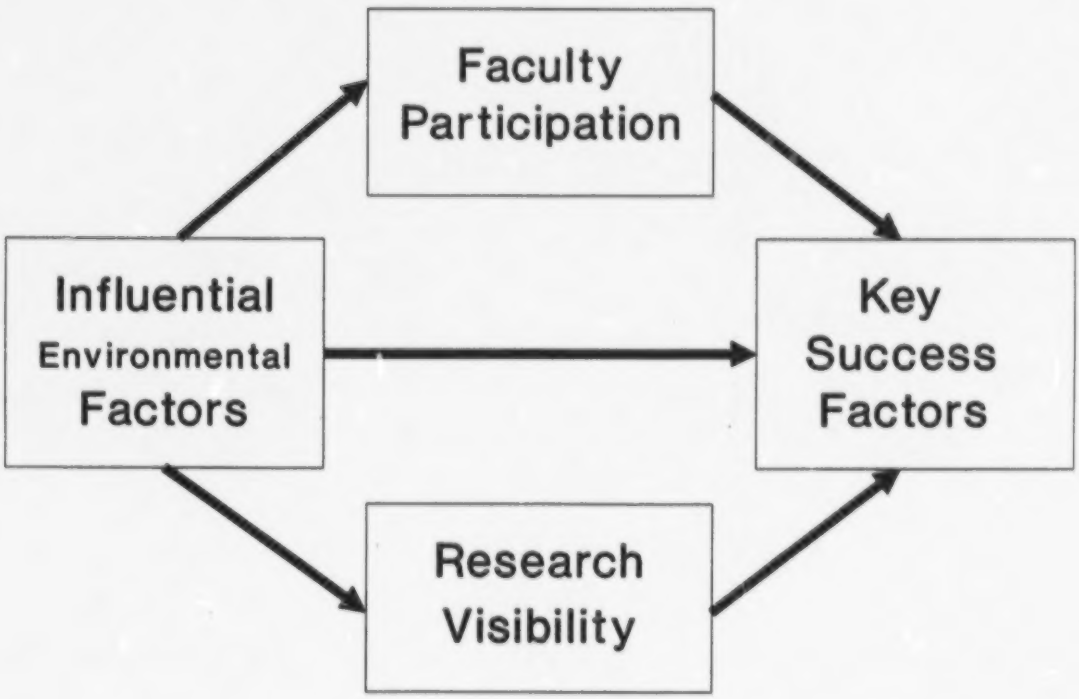
[1] Quartiles can be read as follows: Q1 = first quartile or the response for which 25% of responses were lower; Q2 = second quartile or the response for which 50% of responses were lower; Q3 = third quartile or the response for which 75% of responses were lower.

Figure 2

Research Management Model



Results

The following discussion provides information on the environment in which research divisions operate and characteristics of research functions for a select group of institutions. This information provides valuable insights into those activities and strategies that outstanding research universities are using.

Faculty Participation

On average, the 33 respondents indicated that 46% of their faculty participate in research activities as either principle or co-investigators. These responses ranged from 17% to 75%; with approximately 40% of the responses being estimates. Table 1 summarizes these responses.

Table 1
Faculty Data Summary

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM	Q1	Q2	Q3
# HC Faculty	33	1717	840	525	4000	1310	1400	1925
% Faculty as PIs or Co-PIs	26	46	17	17	75	32	45	57

Results indicated that 67% of responding institutions support their faculty by locating and communicating available funding opportunities. Approximately 52% of respondents reported that assistance is provided on proposal preparation either individually or in seminars. Other types of support included providing funding at either the faculty or university level and facilitating proposal processing. Table 2 summarizes responses concerning the types of support institutions provide faculty members to help them obtain sponsored research.

Table 2
Types of Institutional Support for Faculty Research

Percent	Response
67	Locate and communicate funding opportunities: Includes maintaining faculty profiles, maintaining on-line funding sources, matching faculty members with specific funding opportunities, circulating newsletters that list available funding opportunities, or coordinating interdisciplinary research proposals.
52	Proposal preparation assistance: Includes independent consultation, seminars, workshops, or written manuals.
42	Funding at the faculty member level: Includes funding directed at individual faculty in the form of incentive awards, matching funds, travel funds, assigning graduate students, etc.
39	Seed money: Includes monies for new faculty and in a few instances for new projects.
36	Funding at university level: Includes funding provided at the departmental or higher level in the form of new equipment, facilities, or faculty positions. Also includes distribution of overhead.
30	Proposal facilitation: Includes acting as a proposal clearing house and providing statistical data on research activity.

Research Visibility

The second category of questions dealt with research visibility or the number and magnitude of sponsored research projects. As of 1988, the typical institution in the sample had $97 million in research expenditures, over 1,900 grants, 5 to 10 projects in excess of one million dollars, and a little over one-third of their projects at less than $50,000. Table 3 summarizes the information received in this area.

Table 3
Sponsored Research Statistics

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM	Q1	Q2	Q3
1988 Research Expenditures (in millions)	33	$97	$56	$19	$267	$62	$89	$119
Total # Grants	33	1941	1335	529	7000	840	1650	2500
Largest Project in 1988 (in millions)	32	$5	$5	$1	$22	$2	$3	$6
# of Projects in 1988 in Excess of $1 million	25	8	6	0	25	3	6	14
% of Projects in 1988 less than $50,000	20	36	27	5	88	11	29	59

Influential Environmental Factors

The third section of the survey sought to identify major changes that might have occurred in the internal or external environment that significantly impacted on research activity. Approximately 27% of the respondents thought there had been no such change in the last five years. For those respondents indicating that there had been a major change in the last five years, the most commonly cited changes were a general increase in administrative emphasis on research (63%) and increased funding (54%). Table 4 summarizes the responses from the 24 institutional representatives who believed a change took place.

Table 4
Major Changes in the Last Five Years

Percent	Response
63	Increased emphasis: A general increase in administrative emphasis on research due to a new president or other organizational change, acquisition of a super computer, hiring of a legislative liaison, increased internal funding, or improved incentives for research.
54	Increased resources: A substantial increase in resources due to increased industry or governmental funding, gifts, or a favorable change in state law.
25	Established specific goals: Includes the establishment of specific goals such as obtaining interdisciplinary projects, achieving a specific external ranking, or increasing interaction with industry.
17	Decreased emphasis: Negative factors which resulted in decreased emphasis or support of research including decreased funding and organizational changes.

Key Success Factors

The final section of the survey focused on key factors used to monitor or measure a research program's success. It should be noted that while most respondents could cite those factors used to measure the success of the research program, it was not clear whether or not these factors were selected consciously as factors necessary for the attainment of objectives, or because they were the easiest factors to measure. According to Maciariello (1984), key success factors should be chosen that are essential to the attainment of the objectives of the organization, or in this case, subunits of the organization. Further research should determine to what extent research divisions are selecting appropriate key success factors.

Dollars as a measurement of success were easily the most often cited monitoring tool with 67% of respondents making such a use. Approximately 39% of respondents used total number of proposals or awards as a measure of success. Measurements of faculty participation, quality of research, and external rankings or reviews were each stated as being used by 27% of the respondents. Table 5 summarizes the measures used to evaluate the successfulness of research programs.

Table 5
Measures of Research Success

Percent	Response
67	Total funding: Level of funding in total or federal dollars.
39	Total number of awards: Proposal or award measures including percent of proposals funded versus awarded, percent of new and competing awards, increased activity with industry, number of proposals submitted, number of awards, and number of large awards.
27	Quality of research: Quality measures include number of publications, citations, awards, and general public awareness of the university.
27	External measures: External rankings or reviews such as NSF rankings, outside accreditation, graduate student placement, and sponsor feedback.
27	Faculty measures: Includes the number of faculty participating in research, the average research dollars expended annually per faculty member, the general ability of the university to attract high quality faculty, and informal faculty feedback.
18	Internal measures: Internal reviews which include monitoring the level at which specific goals have been achieved as well as self-study activities.

Respondents from 33 institutions provided information on strategies that may have contributed to their success as a research institution. Over 55% of respondents believed that the ability to retain high-quality, aggressive faculty was the basis of their success. About 42% of the respondents thought success could be traced to an overall environment that encouraged and supported research. In excess of 39% of respondents credited their success to administrative emphasis. Table 6 summarizes the factors or strategies to which respondents attributed success.

Table 6
General Factors Influencing Success

Percent	Response
55	General quality and aggressive nature of faculty employed.
42	Environmental factors: General characteristics of university and its environment that encourage and support research. Includes size, historic reputation, non-monetary support of the proposal process, and policies which reward excellence in research.
39	Emphasis on research: General university emphasis on research which may be supported through a specific planning process.
30	Focus on Strengths: Strategy of focusing on existing strengths of a university or its physical location. Development of interdisciplinary projects or research centers.
27	Monetary support: Ability to obtain monetary support from industry or government along with the flexibility to use funds in a manner which supports research.
21	Outstanding faculty: Ability to attract outstanding faculty and graduate students.

Discussion

The preceding section provides valuable information on activities and strategies used in research divisions of universities with outstanding research programs. By dividing this group into subgroups based on success (as measured by change in rank between 1978 and 1988), it is hoped that further insights will become apparent. It should be noted that a higher rank is associated with achieving a lower rank number; therefore, an example of an increase or positive change in rank would be a change from rank position 21 to rank position 15.

Administrators serving as "cheerleaders" for more research are engaging in an ineffective method to increase research funding unless other actions are taken; for example, setting specific goals and supporting these goals with appropriate resources. This is in keeping with the MCS model. Setting realistic goals and objectives is critical to the management control process. In addition, these goals and objectives must be supported with appropriate strategies, including budgets, that take into consideration internal and external constraints. The success of these strategies is then monitored through key success factors. Thus, managers take an active role in supporting the MCS

process by setting realistic goals and objectives and providing appropriate resources for obtaining these goals and objectives.

Administrators at universities that are relatively less successful in attracting research funding[2] take more initiative to help researchers with proposal preparation and provide funding at the individual faculty member level. While this at first seems counter-intuitive, in that one would think that those universities that support their faculty would be the highest ranked universities, it makes more sense when the research operation is looked at in the context of Chaffee's (1985) work. These universities are focusing their attention at the individual faculty member level. They are using a linear or programmed approach to teach faculty members how to play the research game; or how to win research grants. In this situation, faculty members have a fairly structured information need; they need to know how to write effective research proposals and they need some financial support to help them get started.

A positive change in rank occurred for those institutions that could attract high quality faculty who in turn won grants and contracts. Mentioning the general quality and aggressive nature of faculty tended to occur more often at those institutions with very large grants. As would be expected, the ability to attract large grants (one million dollars or more, for example) was positively related to higher 1987 rank.

Those universities that are ranked higher, have faculty that are adept at obtaining research grants; the question is not so much how to obtain grants but how to differentiate their research program from those research programs at other good research universities in order to improve their rank. These universities work under a more adaptive strategy where they have the flexibility to take advantage of certain opportunities that arise; however, they are still tied to a central research division structure for approval and support. Porter (1980) describes this strategy as differentiation. Differentiation involves "creating something that is perceived *industrywide* as being unique."

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[2] Since all universities are in the top 100 in attracting research dollars, any hint of a "higher" or "lower" rank must be considered as relative to other research universities.

There is some evidence to suggest that top research universities operate in an interpretive environment. The research division acts more as a clearing house than as a support or control function. In general, those institutions ranking in the top research universities tend not to support their faculty on an individual basis. The exception to this was for new faculty where they may have many of the same support measures as do lower ranking institutions. One possible reason for this is that faculty at these top institutions have risen through the linear and adaptive phases of development and have developed a similar cultural conscience, in that they seek research opportunities without needing assistance or control.

How does an institution increase research productivity?

- Emphasize improved research activity by setting specific goals and supporting those goals with necessary resources.
- Recruit and retain outstanding research faculty.
- Monitor progress toward objectives using specific external measures.
- Provide assistance in writing proposals.

These factors are consistent with the characteristics of a MCS and seem to indicate that those who are actively managing the unstructured management control areas of the Gorry and Scott Morton (1986) model are on the right track. Note, however, that none of the institutions seem to have a formal sense of a MCS.

Future Research Opportunities

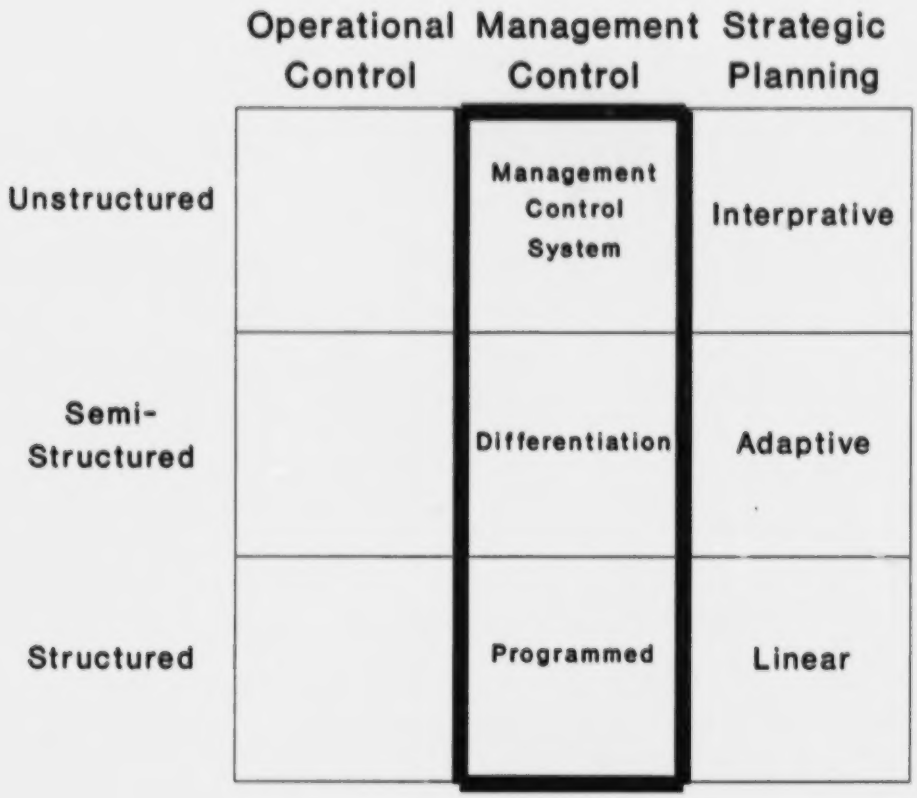
Given the limited literature available in this area, this study was by necessity exploratory in nature. While some of the factors which contribute to the success of an outstanding research university have been identified, there are many opportunities for further study. Future research should broaden the sample to determine the patterns of strategy used by those research institutions with

lower levels of activity. An expanded sample would also allow for the use of more powerful statistical techniques that require a larger sample.

There appears to be some evidence of a naive usage of MCSs and critical success factors in the area of management control. It is unclear, however, whether the respondents have chosen these factors within a MCS context. Also, while it appears that goals and objectives are being set and progress monitored, this is done as part of an informal process and may be more an intuitive than conscientious. Further research is required to determine the the quality of the MCSs that are being used.

Figure 3 provides a revised version of the Gorry and Scott Morton (1986) model. While conclusions from the research performed are preliminary, they appear to support the use of linear strategy at the unstructured level of the management control process; the use of an adaptive or differentiation strategy at the semi-structured level of management control; and the use of the MCS and interpretive strategies at the unstructured level of the management control process. There also appears to be a hierarchical path that, if developed, leads to the use of management control systems and or success. Those research divisions that have recognized that they work in an unstructured environment appear to have developed systems that are similar to a MCS to cope with, and take advantage of, their situation. Further research will need to be performed to determine whether the causal relationship that is suggested actually exists.

Figure 3
Information Systems Framework



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